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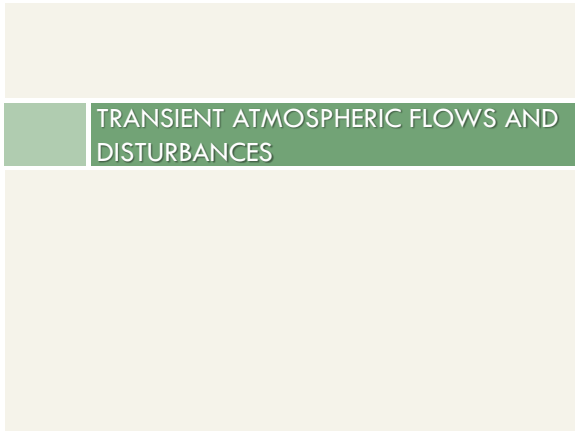
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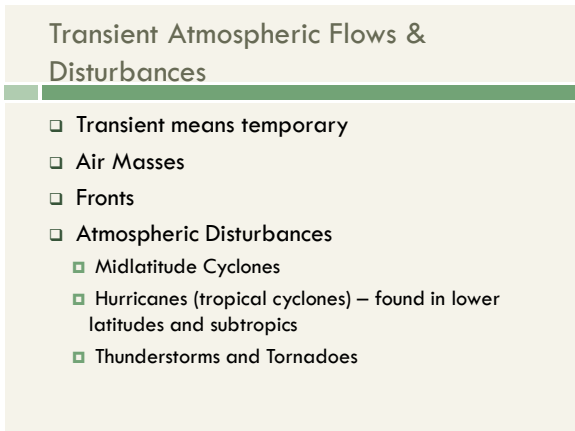
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## Air Masses

- Large variable parcels of air that are distinct from one another. It dev. its xteristics by remaining over a land/sea surface long enough to acquire the xteristics of that surface.
- Therefore, only stable air becomes an air mass, since it has to remain over a surface for a few days. E.g. over a desert, snow, ocean, etc. So air masses form in areas of anticyclonic conditions.
- Air Mass Source Regions
- Air Mass Classification
- Air Mass Movement

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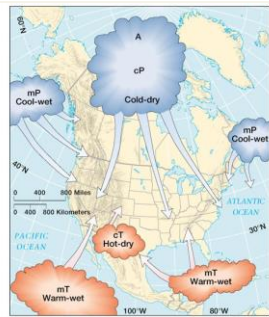
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## Air Masses Affecting North America

- Air masses modify the regions over which they flow, but they become modified themselves.
- In N/America, N-S air movement is free, but E-W movement is not (why?).




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TABLE 7-1 Simplified Classification of Air Masses

Type	Code	Source Regions	Source-Region Properties
Arctic / Antarctic	A	Antarctica, Arctic Ocean and fringes, and Greenland	Very cold, very dry, very stable
Continental polar	cP	High-latitude plains of Eurasia and North America	Cold, dry, very stable
Maritime polar	mP	Oceans in vicinity of 50° - 60° latitude	Cold, moist, relatively unstable
Continental tropical	cT	Low-latitude deserts	Hot, very dry, unstable
Maritime tropical	mT	Tropical and subtropical oceans	Warm, moist, of variable stability
Equatorial	E	Oceans near the equator	Warm, very moist, unstable

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## Fronts

- ❑ A front is formed whenever 2 different air masses meet. A typical front is several or 10s of km wide.
- ❑ Formation of Fronts – a front usually slopes, so that warm air always lies on top of cold air. Fronts lean so much that they are almost more horizontal than vertical. (See next slide)
- ❑ Warm Fronts (further slides)
- ❑ Cold Fronts
- ❑ Stationary Fronts – when neither air mass is displaced (see weather symbols)
- ❑ Occluded Fronts – when a cold front overtakes a warm front

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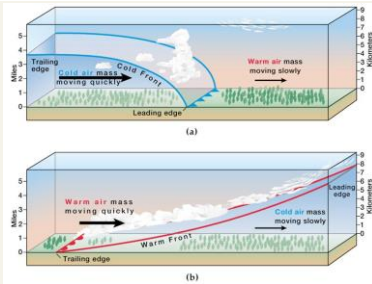
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## Formation of Fronts




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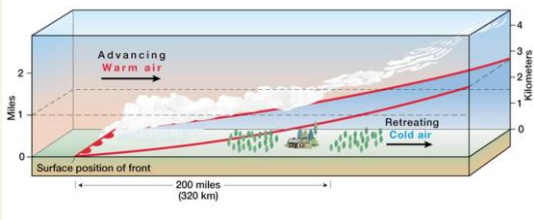
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## Warm Fronts



When a warm air mass actively overrides a cold air mass.

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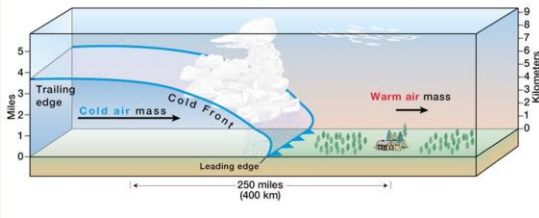
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## Cold Fronts



When a cold air mass actively overrides a warm air mass.

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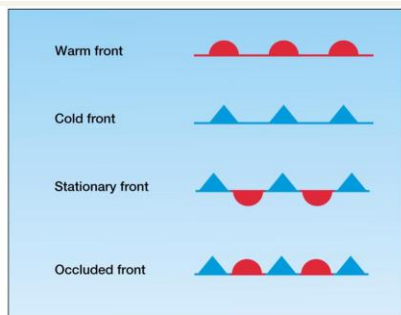
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## Weather Map Symbols



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## Atmospheric Disturbances

- Why are they called 'major' and 'minor'?
- Major Disturbances
  - Midlatitude Cyclones and Anticyclones
  - Hurricanes
  - Minor Disturbances
  - Easterly Waves
  - Thunderstorms
  - Tornadoes

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## Midlatitude Cyclones

- ❑ A typical mid-latitude cyclone has a diameter of about 1000 miles. It's a vast cell of low pressure air.
- ❑ They have a converging counter-clockwise movement in the N/hemisphere (opposite in the south).
- ❑ This flow attracts cold air from north and warm air from south causing 2 fronts.
- ❑ A mid-latitude anticyclone is the opposite (next slides).

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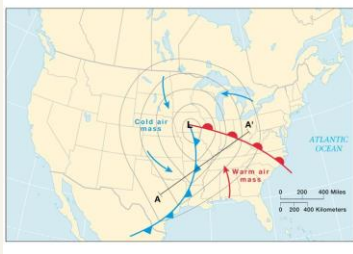
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## Midlatitude Cyclones




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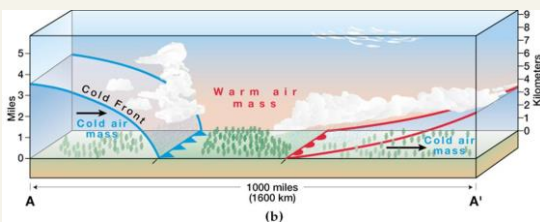
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## Midlatitude Cyclones

### Cross Section




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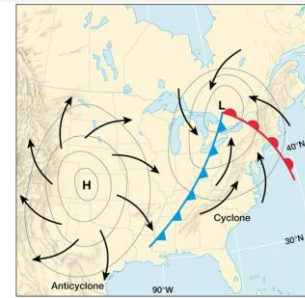
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## Midlatitude Cyclones and Anticyclones

- In a mid-latitude anticyclone the air diverges out in a clockwise fashion (opposite in the S/hemisphere). It's a high pressure cell that causes good weather.
- A typical mid-lat cyclone develops from origin to maturity in 3 to 6 days and takes about the same time to dissipate, once at maturity.




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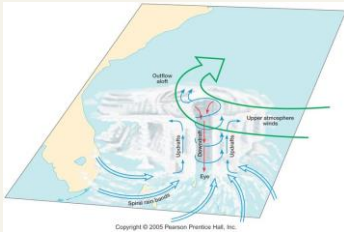
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## Hurricanes

- The low latitudes (tropics) are monotonous weather-wise, unless when there's an occasional hurricane.
- They are called different names:
  - Hurricanes – N & Central America
  - Typhoons – Western N. Pacific & E. Asia
  - Baguios – Philippines
  - Cyclones – Indian Ocean & Australia




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## Hurricanes

- They are intense, rain-drenched, migratory, destructive storms.
- They consist of prominent low pressure centers that are circular, and have a steep pressure gradient. As a result, strong winds spiral inwards.
- Winds must reach 64 knots (**74 mph**) in order to be called a hurricane. Most times however, winds are double or triple that speed, even over 200 mph.

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## Hurricanes

- ❑ They are considerably smaller than mid-lat. cyclones, and have a diameter of btw 100-600 miles.
  - ❑ They produce towering cumulonimbus clouds (up to 10 miles!).
  - ❑ The troposphere is only 11 miles (where it's highest at the equator).
  - ❑ Heavy rains increase in intensity as you near the eye wall.
- ❑ Strange feature: **the non-stormy eye**. Here wind movement is downward, and anticyclonic (hence "good weather").
  - ❑ So, in a hurricane, winds don't converge to a point; they reach their highest speed at the eye wall.
  - ❑ The eye is about 10-25 miles in diameter, an unusual calmness in the middle of the surrounding chaos.

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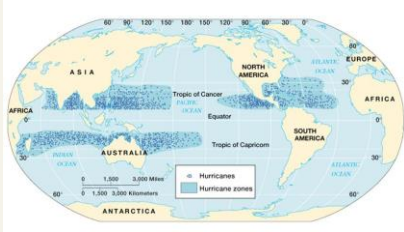
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## Hurricane Locations

Why hurricanes are not found at the equator.

Ocean water has be warm in the tropics, at least 80 degrees F, and a few degrees N & S of the equator.

Hurricanes do not form in lower than 10 degrees N or S, because the Coriolis effect is too low there.




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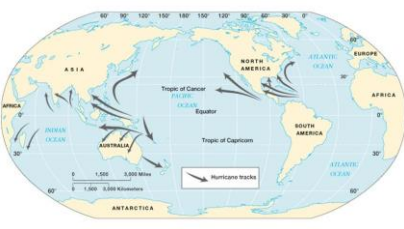
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## Major Hurricane Tracks

Hurricanes require an enormous supply of energy, which is provided by the latent heat that is released when water condenses, as the air rises rapidly.

An average mature hurricane produces in one day, as much energy as is generated by all the electric power plants in the U.S. in a whole year!




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## Hurricane Facts

- Hurricanes usually grow from pre-existing disturbances in the troposphere, E.g. Easterly Waves (discussed later). Easterly waves provide the low-level convergence & lifting that starts a hurricane.
- However, fewer than 10% of easterly waves ever become hurricanes. Therefore, "all hurricanes come from easterly waves, but not all easterly waves become hurricanes". Similar to the definition for clouds & precipitation.
- The overwhelming cause of damage and loss of life comes from the storm surges (wind-driven water), and not really the high winds and rain (e.g. Katrina). This can be as much as 25ft above normal tide level.
- 90% of hurricane-related deaths are due to drowning.
- The strongest & largest are those of the China Sea. Here in E/Asia, they're sometimes called "super typhoons".

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## Hurricane Categories Determined

Saffir-Simpson Hurricane Scale			
Scale Number (Category)	Sustained Winds (MPH)	Damage	Storm Surge
1	74-95	Minimal: Unanchored mobile homes, vegetation and signs.	4-5 feet
2	96-110	Moderate: All mobile homes, roofs, small crafts, flooding.	6-8 feet
3	111-130	Extensive: Small buildings, low-lying roads cut off.	9-12 feet
4	131-155	Extreme: Roofs destroyed, trees down, roads cut off, mobile homes destroyed. Beach homes flooded.	13-18 feet
5	More than 155	Catastrophic: Most buildings destroyed. Vegetation destroyed. Major roads cut off. Homes flooded.	Greater than 18 feet

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## How are Hurricanes Named?

- Since 1953, Atlantic tropical storms have been named from lists originated by the National Hurricane Center and now maintained and updated by an international committee of the World Meteorological Organization. The lists featured only women's names until 1979. After that, men's and women's names were alternated. Six lists are used in rotation. Thus, the 2001 lists will be used again in 2007. One name for each letter of the alphabet is selected, except for Q, U and Z.
- The only time there is a change in the list is if a storm is so deadly or costly that the continued use of the name would be inappropriate for reasons of sensitivity. When this occurs, the name is stricken from the list (and retired) and another name is selected to replace it.
- Source: [www.fema.gov](http://www.fema.gov)

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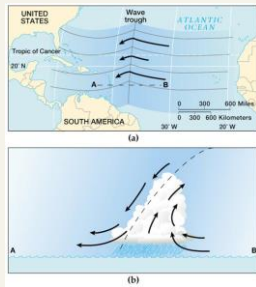
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## Easterly Waves

- These are long & weak migratory low-pressure systems, occurring btw lat. 5 & 30 degrees.
- Usually about 100km long, and drift slowly to the west, in the direction of trade winds.
- Air is divergent ahead of the wave (good weather), but behind the wave, air is convergent (thunderstorms).
- The convergent part is what sometimes intensifies into a hurricane.




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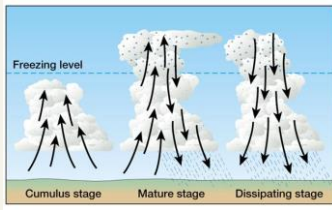
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## Thunderstorms

- A thunderstorm is a violent convective storm, accompanied by thunder and lightning.




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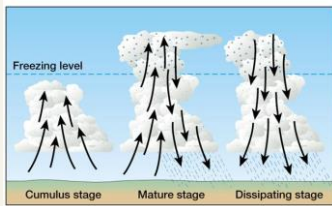
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## Thunderstorms

- Thunderstorms are localized and short-lived, and are always assoc. with vertical air movement, humidity and instability.
- They produce towering cumulonimbus clouds and showery precipitation.




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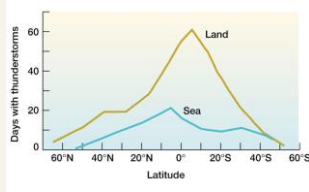
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## Thunderstorms and Latitude

- Most thunderstorms occur in the tropics, esp. in the ITCZ. Also, in the summer in the mid-latitudes. This is because land is warmer then, and the process is intensified. They decrease as you move towards the poles, and don't exist much past 60 degrees N & S.
- They are often found in combination with other storms like hurricanes and tornadoes




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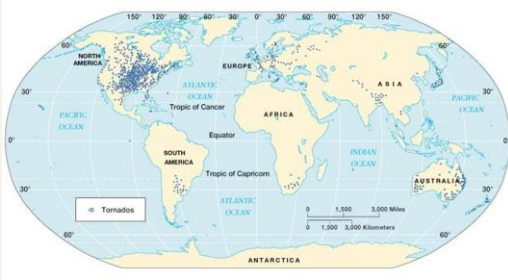
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## Distribution of Tornadoes




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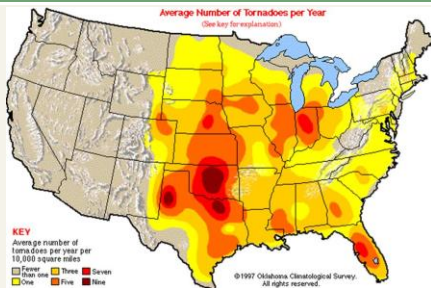
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## Distribution of Tornadoes




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